The Role of LEO in the Global Exploration Roadmap Scenario

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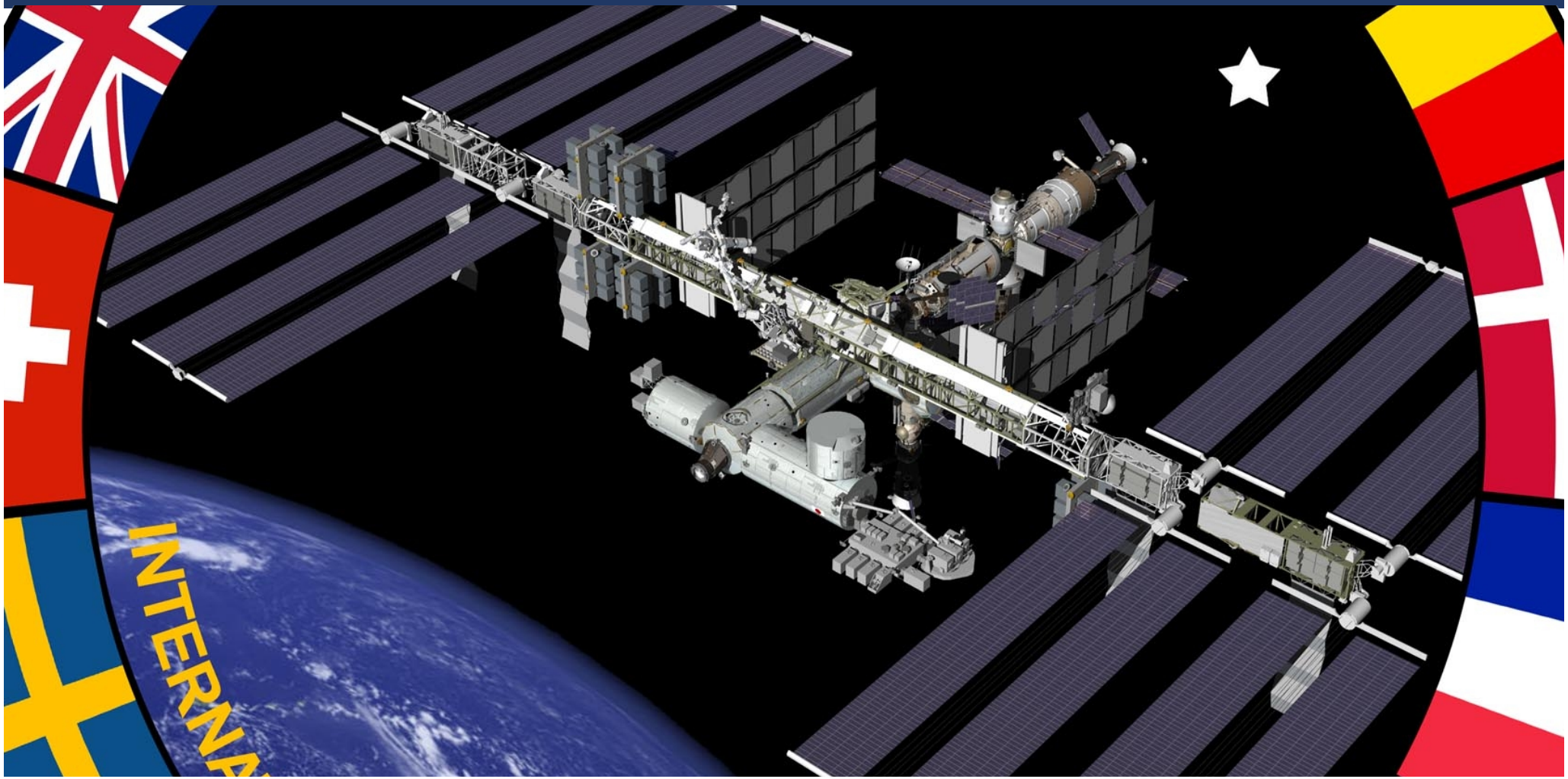
Introduction

- **The ISS partner agencies are active in ISECG**
- **All partners believe that missions to the lunar vicinity can begin while we are still operating the ISS**
- **The updated GER will make it clear that LEO will remain an important destination for all agencies, including non-ISS agencies**

International Space Station and LEO Today

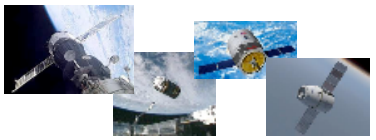


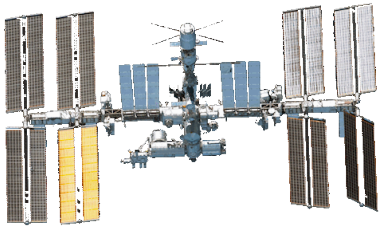
The Many Roles of the International Space Station

- **Conduct the research and technology demonstrations to enable long duration human spaceflight into the solar system**
- **Enable the development of a commercial market in low earth orbit**
- **Advance benefits to humanity through research**
- **Basis for international cooperation in exploration**

ISS – Accomplishments to Date

- **Continuously crewed since November 2000**
- **Over 200 different crewmembers from 15 countries**
- **>2000 investigations and counting**
- **Healthy resilient cadence of cargo supply enabled by partnership**





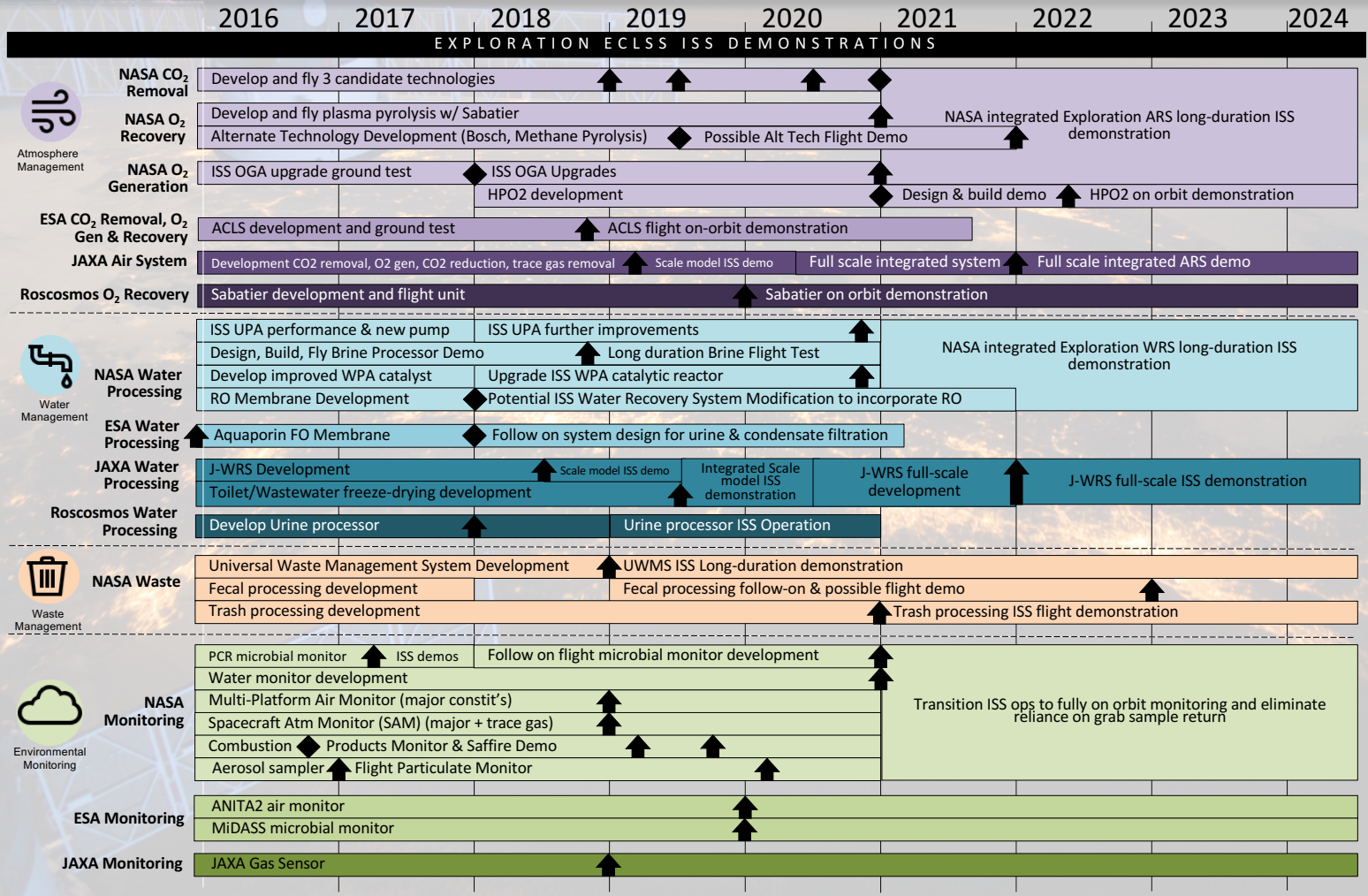
ISS and LEO Current State

- **Continuous human presence in LEO**
  - Continuous human presence has been sustained over the past 17 years
    - U.S. Commercial crew will add an additional crew member
- **Strong International Partnership**
  - Current ISS Inter-Government Agreements (IGA) have been in place for nearly 20 years and provide treaty-level agreements between US, Russia, Canada, Europe and Japan
  - All partners supporting ISS operations to 2024
- **Research and Development**
  - Research on ISS spans life and physical sciences, human health, astrophysics, earth sciences, space science, many others
  - Users have been greatly expanded into private industry and other government agencies
    - Pharma, materials, manufacturing, human health, model organisms, consumer products
  - National Lab investment is enabling new and innovative uses of LEO (cubesats, testing of low TRL technologies, model organism research into human health, many others)

ISS and LEO Current State

- **Development of commercial markets in LEO**
  - U.S. cargo and soon crew supplied by private industry
  - Commercial crew and cargo support commercial launch industry
    - ~14% of world launch market goes to ISS
  - Commercial research and technology development supply and demand is increasing
    - However - currently, private industry and other U.S. government agency users are probably not in a position to fully pay for capabilities (transportation, crew time, power, etc.) without ongoing government support
  - Interest by private sector companies in establishing commercial human platforms in LEO
- **Deep space - long duration Exploration**
  - Requirements for human health and performance research and technology/system demonstrations for habitation systems, and other exploration systems are currently planned to be completed by 2024/2025

Exploration ECLSS Plan for ISS



Fast Forward to 2024

Looking to the future in 2024 – A Fair Amount of Certainty

- **Continuous human presence will have been sustained for over 24 years**
- **China will be operating their newly completed space station further expanding opportunities for accessing and conducting research in LEO**
- **U.S. commercial crew flights will have enabled greater flight opportunities to ISS and LEO**
- **NASA's exploration-related human research and technology/system demonstrations in LEO are nearly complete, with focus shifting to deep space**
  - NASA expects to have some ongoing LEO needs to support long-term deep space missions.
- **Human spaceflight missions in the lunar vicinity will have begun**

Looking to the future in 2024 – Less Certainty

- **Whether ISS private industry users will be able to pay for services currently being provided by the U.S. ISS National Lab.**

- **Whether commercial market demand (tourism, marketing, in-space manufacturing, etc.) will be able to sustain private commercial platforms without ongoing significant government investment**

- **What NASA is hearing from stakeholders:**
  - **A formal acknowledgement of a LEO human-spaceflight-enabled commercial policy would be helpful for building business cases**
  - **Important that the government maintain its demand for LEO capabilities**
  - **Desire for pricing policy for LEO services**
  - ***Transition from ISS needs to be gradual and well-planned. No advocates for a hard end date of 2024.***

Considerations for Future of ISS and LEO

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- **Timing - Transition indicators**
  - Completion of exploration-related research and technology development requiring ISS
  - Demand from government and private industry including research and for-profit motivated activities, and whether that demand will support private LEO platforms and associated transportation costs
  - Establishment of cislunar Gateway capabilities and execution of missions beyond LEO

- **Affordability in the larger HSF Exploration context**

Considerations for Future of ISS and LEO

- **Policy Considerations**
  - Role of the government in fostering R&D across private industry and non-NASA government agencies
  - Policy on use of ISS for purely commercial purposes
  - Public-private partnership models

- **Government needs for future LEO platform(s)**
  - Future scope of government commitment in LEO spans different platform types - continuously crewed long duration platform, periodic presence on long duration platform, periodic presence on short duration platform…or a combination
    - ISS agencies are increasingly talking about future needs
  - Scope of the platform has a dramatic effect on transportation industry

- **Health of on-orbit ISS elements**
  - Many ISS elements will have considerable structural life after 2028
  - Some systems, including the solar arrays, will need to be replaced by the end of the 2020s in order to maintain the current configuration
  - Maintenance levels less than originally anticipated

Element	Year Launched	+30 years
FGB/Node 1	1998	2028
US Lab	2001	2031
Node 2	2007	2037
Columbus/JEM	2008	2038
Node 3/Cupola	2010	2040
Truss segments	2000-2009	2030-2039


Human activity in LEO is here to stay